APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1991-026A

TITLE TRANSFER OF EXPEIMENT TRAIN TO THE WORKSTAND AREA AND INSTALLATION INTO THE LONG MODULE IN THE O&C BUILDING

DOCUMENT NUMBER/TITLE OMI L5046, EXPERIMENT TRAIN-LONG MODULE INSTALLATION

PREPARED BY ISABELINO RODRIGUEZ, A91-F674

DATE 20 JULY 1994

REQUIRED APPROVAL

CONTRACTOR	____ DESIGN	____ R & QA	X OPERATIONS	X SAFETY
NASA	____ DESIGN	____ R & QA	X OPERATIONS	X SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORGN.	DATE
JOHN LINK		CS-PPD-1	8-7-94
JIM JOYNER		RT-SRD	8/25/94
MALCOLM GLENN		RT-SRD-1	8/24/94
NORM JATZ		A91-F276	7/22/94
WENDY D. ZIRNFUS		A91-F670	8/10/94
RON GILLETT		RT-SDE	8/29/94

CONTRACTOR DIRECTOR OF SAFETY

NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL

NUMBER: SLO-KSC-1991-026A
CHANGE 1, JULY 94

OPERATION - To transfer the experiment train to the workstand area and install the experiment train into the long module in the Operations and Checkout (O&C) Building.

SUPPORTING DOCUMENTS - The associated operational procedure and System Assurance Analysis (SAA) are as follows:

- OMI L5046, Experiment Train - Long Module Installation
- SAA01FS027-002, 27.5 Ton Bridge Crane - O&C

GENERAL DESCRIPTION - The task below requires up to eight persons [including "spotter(s)"] to be under the suspended European Space Agency (ESA) strongback during transfer of experiment train to the workstand area and installation to the long module as follows:

- o OMI L5046, Transfer to Workstand Operation

Experiment train transfer/installation operations are performed in the O&C low bay using dual 27.5 ton bridge cranes. The suspended hoist beam extends out beyond the envelope of the long module, which exposes personnel to a suspended load while attaching/disconnecting grounding strap, removing/installing trunnion safety caps, attaching/removing cable assembly, removing/installing the bolts, nuts and washers that secure lower frame to long trolley, rotation of roller assembly, removing/stowing brakes, loosening/ rotating/stowing safety claws, and "spotting" the operation.

During contingency payload grounding operations, one person will be permitted to work under the suspended load.

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a - These operations cannot be conducted without placing personnel beneath the suspended hoist beam, which extends out

beyond the long module. Experiment train/long module operations in the O&C have been evaluated, and it has been determined that there are no procedural/operational means to eliminate exposure to a suspended load that reduce the hazard level. Redesign of the entire module hoisting system is not feasible.

Alternate Standard Requirement #1b - The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of positioning of the experiment train over the workstand.

Alternate Standard Requirement #1c - The maximum number of personnel allowed under the suspended hoist beam during transfer of the experiment train to the workstand area and into the long module is eight.

Alternate Standard Requirement #1d - Experiment train transfer/ installation operations will be accomplished as quickly and safely as possible to minimize exposure time. It will take eight persons [including "spotter(s)"] up to two hours to transfer/ install the experiment train (due to dual crane operations).

Alternate Standard Requirement #4 - OMI L5046 has been revised to permit only the approved number of persons under the suspended hoist beam. The OMI is available on site for inspection during the operation.

Alternate Standard Requirement #6 - Suspended load operations associated with transfer of the experiment train to the workstand area and into the long module in the O&C involve two 27.5 ton bridge cranes. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The 27.5 ton crane hoists are equipped with two magnetic holding brakes (one on the motor shaft and one on the gear reducer input shaft extension), each capable of holding the load up to the crane's rated capacity. Each brake's ability to hold the load (27.5 tons) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load-bearing components.

Dual 27.5 ton cranes are being utilized. The ESA strongback weights 15,000 lbs and the payload can weigh as much as 36,520 lbs. The combined load is 51,520 lbs., which is 46.8% of the cranes' capacity.

The lifting slings are rated at 36,520 lbs and are designed to meet a 2.25 to 1 safety factor based on yield strength and a 5 to 1 safety factor based on ultimate strength.

The 27.5 ton cranes are load tested annually at 100% of their rated capacity. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. A detailed inspection of the lifting slings is performed annually. Nondestructive testing of the slings and crane hooks is performed annually.

Alternate Standard Requirement #7 - A System Assurance Analysis (SAA) has been completed on the 27.5 ton bridge cranes in the O&C. The SAA includes a failure modes and effects analysis/ critical items list (FMEA/CIL) and a hazard analysis (see supporting documents).

The SAA identifies one single failure point (SFP), the hoist gear reducer, which transmits power and reduces rotational speed from the hoist motor to the rope drum. A sheared key or broken teeth would cause interruption of the load path at the gearbox. This failure would result in the load dropping, which could cause loss of life and/or payload.

There is no history of failure with the SFP in the critical failure mode. A detailed inspection of the gear reducer is performed monthly, and gear reducer oil samples are verified annually. The use of high-quality, reliable components and a comprehensive maintenance, inspection, and test program (including preoperational checks) ensures that the crane systems operate properly.

The associated SAA CIL Sheets identify all the rationale for accepting the risk of the SFP including design information, failure history, and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

Alternate Standard Requirement #8 - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9 - Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

Alternate Standard Requirement #10 - Appropriate safety control areas are established before initiating operations. Only the minimum number of people (manloaded in the procedure) will be permitted in this area.

Alternate Standard Requirement #11 - A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. Following any crew change, the new personnel are instructed by the task leader on their specific tasks and warned of any hazards involved.

Alternate Standard Requirement #12 - Personnel beneath the suspended load will be in voice contact with the hoist operator/ task leader. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

Alternate Standard Requirement #13 - Personnel working beneath the load shall be in continuous sight of the hoist operator/task leader.

APPROVAL: **DATE:** 8/27/99

Joel R. Reynolds Jr

James F. Harrington III
Director, Safety
and Reliability (RT)
Kennedy Space Center